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Surface Warfare Officer Community Management Model System Dynamics Proof-of-Concept

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14. ABSTRACT
This system dynamics model was developed to analyze and discern the factors which lead to sustainable numbers of qualified surface warfare officers (SWO) as determined by current and future end-strength requirements and readiness goals. The analysis considered the effects of proposed bonus or separation incentives, other compensation, and quality of life on the quantity and quality of retention and accessions. The model considers all major aspects of manning from initial accessions, training, distribution, and retention. This model serves as a successful proof-of-concept for the utility of system dynamics modeling to realistically model SWO community management functions.

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Foreword

This report was prepared as part of the Integrated Personnel Simulation Technologies project (Program Element 0602233N, PR 00PR01717-01, Research project 0332903324), sponsored by the Office of Naval Research. The work described here was performed during Fiscal Year (FY) 2001.

This is a report on work in progress that intends to introduce the concept of system dynamics and its applicability to integrated modeling. It also serves as a successful proof-of-concept for the utility of system dynamics modeling to realistically model Surface Warfare Officer Community Management functions.

We thank CDR Patrick Rabun (PERS-41P), CAPT John Peterson (N131W), Mr. David Cashbaugh (PERS-11), Mr. Murray Rowe (PERS-00B), CAPT James Tanner (N130A), and CAPT Joseph Harris (N131B) for their constructive input into the development of the proof-of-concept model.

DAVID L. ALDERTON, Ph.D.
Director

Contents

List of Figures

Introduction

Abstract

This technical note describes our findings during the evaluation of system dynamics (SD) as a modeling method. This work was conducted as part of the Integrated Personnel Simulation Technologies (IPST) 6.2 level research project, sponsored by the Office of Naval Research. A technical report that describes the results of our comprehensive study of modeling methods is forthcoming.

This SD model was developed by Navy Personnel Research, Studies, and Technology (NPRST) and CACI, Inc., San Diego, to analyze and discern the factors that lead to sustainable numbers of qualified Surface Warfare Officers (SWO)—under current and future end-strength requirements and readiness goals. The analysis considered the effects of proposed bonuses or separation incentives, other compensation, and quality of life factors on the quantity and quality of SWO retention and accessions. The model considers manning from initial accessions and training through distribution and retention. This model serves as a successful proof-of-concept of SD to realistically model SWO community management functions.

This level of analysis and model use is best suited for strategic planning where leadership tests alternatives for managing their organization through the use of a computer simulation. This particular model includes several difficult to measure (quantify) variables.

Objective

The SWO Community Management Model was developed to:

1. Evaluate SD as a modeling method
2. Perform analysis of SWO personnel shortfalls

Background

The Navy's personnel force is managed by "community managers" at the individual skill level and strength planners at the all Navy level. Community managers are responsible for skill level accessions, training, advancements/promotions, rotation policy, retention, and separations to ensure that the skill is adequately manned to meet Navy operational goals. Strength planners closely monitor and manage the force strength (inventory level) to ensure execution of Navy strength objectives within fiscal constraints. This includes sending the signal to Navy recruiters on how many new Sailors to bring into the force.

Surface Warfare is one of several officer communities and contains approximately 8,100 officers. Surface officers are primarily assigned to jobs at sea. Surface Warfare and other officer communities manage their personnel inventory relative to paygrades: Ensign, Lieutenant Junior Grade, Lieutenant, Lieutenant Commander, Commander, Captain, and Admiral.

Problem Statement

It is difficult for managers in broad functional areas, such as the SWO community, to fully understand the impact of their decisions on the overall officer personnel program. A policy implemented in one functional area may not produce the desired results because of constraints imposed by other functional areas; this is the type of problem SD is designed to ameliorate.

During interviews with SWO Community Managers at the Navy Personnel Command (NPC), it became apparent that there was a significant shortage of mid-grade (Lieutenant and Lieutenant Commander) SWOs to fill department head (DH) and other LCDR billets at sea and ashore, as shown in Figure 1. The data represents the SWO personnel inventory (8,132) as of December 1999; the fiscal year officer authorization was 7,367. It was provided courtesy of the SWO community manager as a depiction of the gap between authorized officers (requirements) and the inventory of officers by year group. The solid line represents the number of officers in each skill category (designator) and paygrade that are paid for or authorized. This is known as officer programmed authorizations or OPA—the shortfalls are between year groups 1986 and 1993, where these individuals are currently expected to fill DH and LCDR billets.

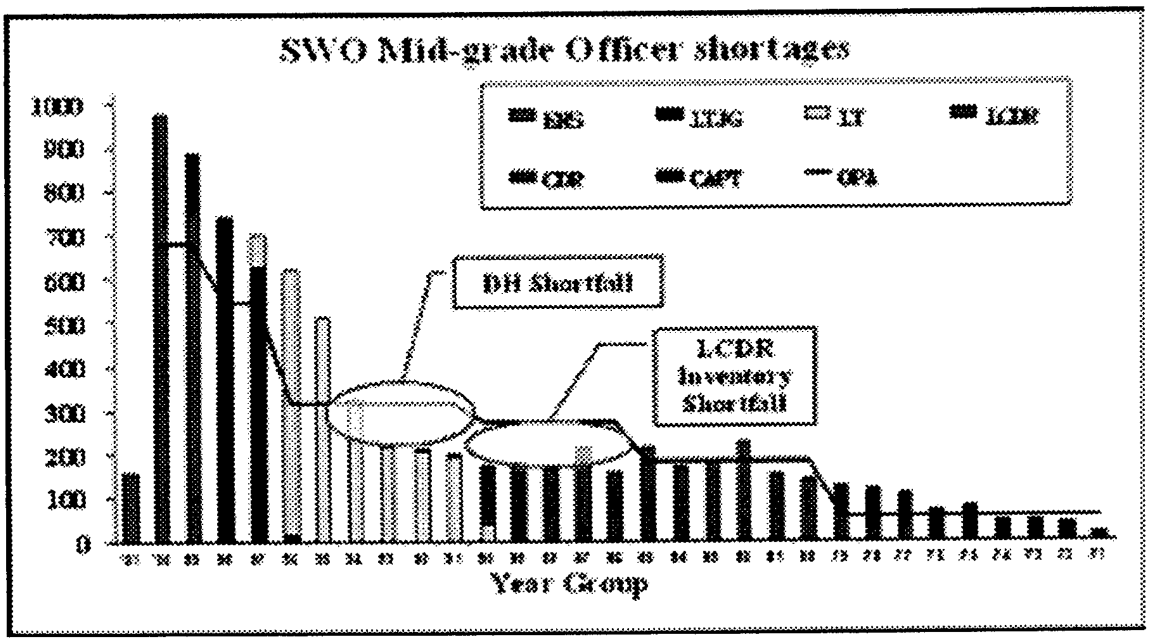


Figure 1. Problem Description Graph.

As an example of the difficulty in keeping critical billets filled at sea, in 1999 SWO department head tours had lengthened to 50+ months whereas the normal career path calls for 36-month tour lengths. In fact, the problem was so severe that the SWO community instituted officer continuation pay (OCP), which pays $50,000 to SWOs who complete the entire department head tour. It is paid as follows: $10,000 upon signing,

$10,000 on first day of department head school, and three anniversary payments of $10,000 each. As of January 2001, over $18 million in OCP bonuses has been paid to over 1,400 officers.

Additionally, other short-term efforts designed to alleviate the billet shortfalls include:

- Downgrading a percentage of department head billets to division officers
- Receiving help from the Limited Duty Officer (LDO) community to man traditional SWO billets
- Moving division officers "early" to department head billets

Approach

Systems dynamics was chosen as the modeling technique to address the problem of mid-grade officer shortfalls, because it is a useful and powerful tool for understanding complex problems. Specifically, it allows the modeler to represent the complex feedback behavior of managing the officer force. Feedback refers to the situation of X affecting Y and Y in turn affecting X, perhaps through a chain of causes and effects. SD allows the modeler to take the information about a system's structure that normally remains hidden in mental models and represent it in a computer simulation. A mental model represents an individual's understanding of the system.

Jay W. Forrester, Massachusetts Institute of Technology (MIT) developed the field initially.[1] The span of applications for SD has grown extensively and now encompasses work in:

- Corporate planning and policy design
- Public management and policy
- Biological and medical modeling
- Energy and the environment
- Theory development in the natural and social sciences
- Dynamic decision making
- Complex nonlinear dynamics

Methodology

SD is a methodology for studying the complex feedback systems found in business and other social systems. In fact, it has been used to address practically every sort of feedback system. While the word "system" has been applied to many situations, "feedback" is the differentiating descriptor here.

[1] Forrester, J.W., (1961), *Industrial Dynamics*, Cambridge, MA: MIT Press.

The methodology for developing SD models can be summarized in six steps (Note: this methodology is not unique to SD models):

1. *Identify* the problem
2. *Develop* a dynamic hypothesis explaining the cause of the problem
3. *Build* a computer simulation model of the system at the root of the problem
4. *Test* the model to be certain that it reproduces the behavior seen in the real world
5. *Devise and test* in the model alternative actions that alleviate the problem, and
6. *Analyze*, *design*, and *evaluate* alternative actions

The methodology is iterative. Rarely, is an analyst able to proceed through these steps without reviewing and refining an earlier step. The first problem identified may only be a symptom of a still greater problem. For example, in this study, department head shortages were a symptom of several underlying problems including poor retention, high attrition, and low accessions.

In general, a properly developed SD model embodies the *corporate knowledge* and shared mental models of managers within the organization. SD models are readily understood, because SD models are represented graphically and reflect real-world entities, policies, and decisions. Moreover, SD models do not require simplifications that influence system behavior. SD models are as complex as needed to reproduce the problem behavior—more complexity is wasteful and less complexity fails to capture relevant system characteristics.

Modeling Team

The proof-of-concept model was developed over three months. The combined government-contractor modeling team was comprised of Mr. Rodney Myers (NPRST), Mr. Brian Barry (CACI), Mr. Michael McDevitt (CACI), Mr. Michael Zabarouskas (CACI), and Mr. Rich Yarbrough (CACI). CDR Patrick Rabun (PERS-41P) and CAPT John Peterson (N131W) provided supporting subject matter expertise. Additional structural verification and model review was provided during briefings to Mr. David Cashbaugh (PERS-11), Mr. Murray Rowe (PERS-00B), CAPT James Tanner (N130A), and CAPT Joseph Harris (N131B).

Hypotheses

The first hypothesis was that the primary problem was caused by personnel resignations. This prototype model concentrated on the factors that influence officers' decisions to stay in the Navy or resign. This requires comparisons of the *attractiveness* of a civilian career with the *attractiveness* of a continued career in the Navy. Additionally, in some years, the Navy failed to access sufficient numbers of officer candidates to account for expected losses. In other words, officer force planners inaccurately forecasted future resignations. Of equal importance, during the force downsizing in the 1990s, junior officers were given incentives to resign, thus contributing to the LCDR and CDR shortfalls we are currently experiencing, which returns us to our initial hypothesis of resignations as the root cause of SWO mid-grade shortages.

The second hypothesis was that external variables, such as the state of the economy, are important and have a substantial effect on career decisions. To keep this prototype model simple, unemployment rate was the single external economic variable in the model.

The Navy is divided into two sectors in the model. The "Chain of Command" represents the operational sector of the Navy as Commanding Officers, Squadron, and Group Commanders. "Navy Leadership" represents the senior Surface Warfare leadership (flag officers) and senior administrative leadership in the Bureau of Naval Personnel (BUPERS) and the Navy staff, including the Chief of Naval Operations (CNO). It was assumed that it was necessary to separate the two groups based on chain of command having the daily operational knowledge of the community, and Navy leadership being dependent on the chain of command to provide information, which they would ultimately use to make decisions that establish policy.

The model comprises nine primary variables: resignations, selectivity, SWO community capabilities, operational performance, crew pressure, burnout, retention efforts, congressional actions, and unemployment rate. Each variable was created by the modeling team to represent characteristics of the system in a virtual environment (computer simulation). These variables are defined as:

- Resignations—represents those individuals who separate from service (loss) at the end of his/her obligation period
- Selectivity—represents the ratio of selections to candidates, i.e., the more candidates per selection, the higher the selectivity
- SWO community capabilities—represents the measure of the SWO community's ability to perform its functions based on the quality of its personnel
- Operational Performance—used as a proxy for personnel readiness
- Crew Pressure—represents the amount of "pressure" placed on officers relative to their performance (i.e., pressure is the inverse of performance; the worse the performance the greater the pressure)
- Burnout—represents the measure of officers performing at extreme levels for long periods of time
- Retention Efforts—used to signal the model to increase resources for retention of personnel due to predicted shortfalls
- Congressional Actions—represents the authority to approve policies, such as pay incentives
- Unemployment Rate—National unemployment rate is a limiting factor on the likelihood of finding civilian employment; the higher the rate, the lower the likelihood of finding work, and thus the greater the chances are an officer will stay in the Navy

The model was built to examine the problem of surface warfare manpower shortages for mid-grade officers, Lieutenants and Lieutenant Commanders, specifically with between 6 and 15 years of commissioned service (YCS 6–YCS 15). It was developed to

analyze the Surface Warfare community; however, it can be adapted to other communities with little effort. It examines the behavior of cohort year groups (YG) over 20 years. The model contains 30 YGs, from YG0 through YG29, where the numerical designator indicates years of completed service. The level of aggregation is sufficient with appropriate grouping to track behavior by rank or years of service. This aggregation met the client's explicit requirements to track behavior by YG.

The complete model is depicted graphically as a stock and flow diagram in Appendix A. The variables are documented in Appendix B and the effect graphs are shown in Appendix C. Initialization data for the model is included in Appendix D.

Modeling Software

Vensim™ was the modeling application software used to develop the model. It was chosen because of its subscripting capability and the modeling team's familiarity with its development environment. Subscripting allows the modeler to represent multiple characteristics of a variable. This was significant since Sailors need to be represented by paygrade and years of service. Vensim is an icon-based modeling tool that allows developers/users to conceptualize, document, simulate, analyze, and optimize models of dynamic systems. Vensim provides a simple and flexible way of building simulation models from causal loop or stock and flow diagrams. This model was developed using Vensim DSS32 Version 4.1b. Vensim is a product of Ventana Systems, Inc.

Causal Loop Diagram (CLD)

The first step in evaluating system behavior is to show interrelations between system variables and expose feedback loops within the system and between adjoining system(s). In this case, the system is the surface warfare officer community. An adjoining system is civilian employment. CLDs are developed by gathering variables, and correlating the variables with one another as causally related pairs. One variable is independent, and the other is dependent. Although correlations can be established using statistical samples, subject matter experts' opinions are typically used in the absence of statistical data. For the purpose of this model development, subject matter experts' opinions were used.

Arrows in a CLD connect Independent and dependent variable pairs. The arrows are interpreted as the independent variable "effecting" the dependent variable as an irreversible relationship. Irreversible means that the relationship cannot be reversed (i.e., the dependent variable will never have influence over the independent variable). Correlations between variables are either positive or negative and expressed by a plus or minus sign near the arrowhead. Correlations are positive if the independent and dependent variables both increase or decrease in value together, and negative if they respond in opposite directions. The causal pairs are next connected with other variable pairs, exposing relationships that may not be apparent. Often, causal pairs can be traced by to the original independent variable—creating a feedback loop.

There are 10 main causal loops in the model as shown below in Figure 2. Note: "D" is a symbol for delay or time elapsed before information/material is transferred from the independent variable to the dependent variable. Each causal loop must logically include a minimum of two variables. The practice is to assign a name to each pattern that produces

a "loop," (i.e., begin with an independent variable—trace dependent variables before linking back to the original independent variable). The use of CLDs is critically important for the modeling team to understand key system characteristics—they are also very useful in describing the system to stakeholders. The list below represents the names given to the grouping of the variables as they relate to each other.

1. Resignation Trends
2. Experience
3. Chain of Command—Operational Performance
4. Crew Pressure—Operational Performance
5. Burnout—Operational Performance
6. Retention—Operational Performance
7. Congressional Actions
8. Retention Effort—Attractiveness
9. Navy Leadership—Crew Pressure
10. Selectivity—SWO Capability

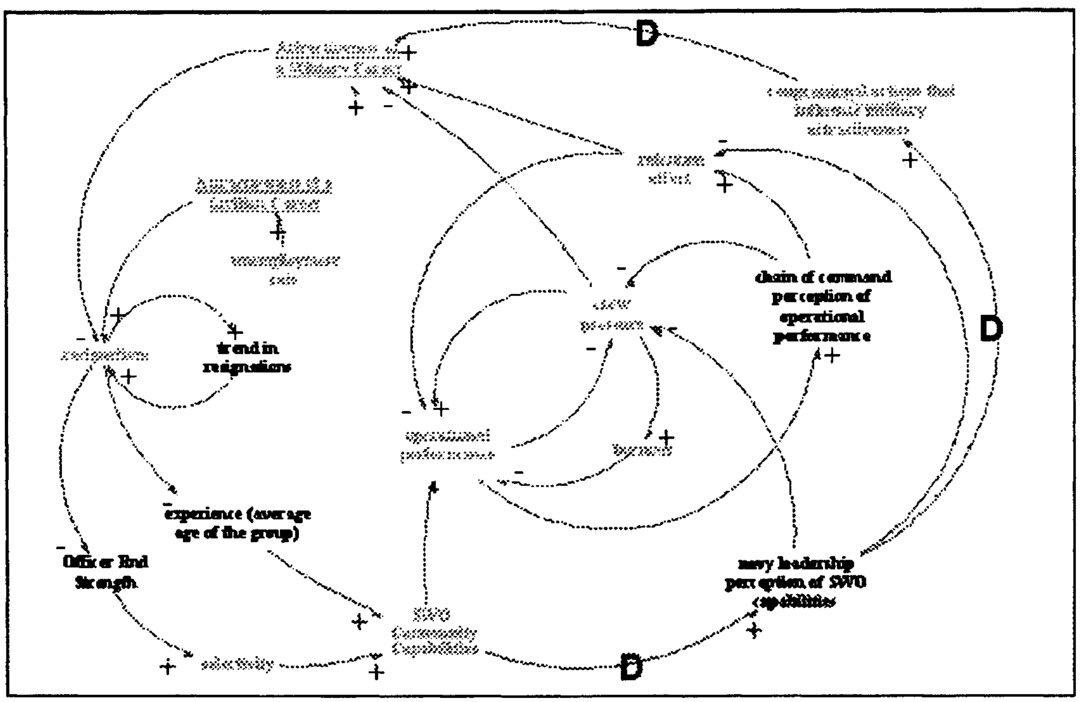
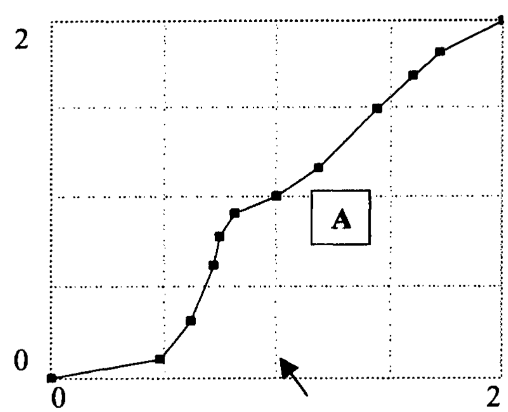


Figure 2. Simplified Causal Loop Diagram—SWOCM Model.

Effect Graphs

The model uses several effect look-up graphs. Effect look-up graphs are a special construction in the Vensim software allowing nonlinear relationships to be represented as a linear relationship. A sample effect graph ("job satisfaction") is shown in Figure 3, where the first variable (effect of operational performance ratio) in the expression is plotted on the horizontal axis, and the second variable (attractiveness of military career) is plotted on the vertical axis. Shown here, the nominal point "A," is where both X and Y values are one. The subject matter experts estimated the default relationships depicted in the effect graphs; however, these relationships can and should be altered during the analysis and evaluation of policies. The relationships (values) are altered via the equation editor. It is necessary, for an analyst, to alter these variables to evaluate the effects to the system when variables change within the model.

The following effect graphs (detailed in Appendix C) are included in the model:



Effect of operational performance ratio on attractiveness of military career

Figure 3. Sample Effect Graph

1. Unemployment rate on civilian attractiveness
2. Unemployment rate on ability to recruit
3. Selectivity on SWO Capability
4. Burnout on Operational Performance
5. SWO capabilities on Operational Performance
6. Crew Pressure on Operational Performance
7. Crew Pressure on Burnout
8. Crew Pressure on Military Attractiveness
9. Retention Effort on Operational Performance
10. Retention Effort on Military Attractiveness
11. Operational Performance on Military Attractiveness
12. Operational Performance on Crew Pressure
13. Chain of Command Perception on Operational Performance
14. Chain of Command Perception on Retention Effort
15. Navy Leadership Perception on Retention Programs
16. Navy Leadership Pressure on Legislature.
17. Military vs. Civilian Attractiveness Gap on Resignation

The primary purpose of this modeling effort was to evaluate SD as a modeling method, and secondly to perform analysis of SWO personnel inventory shortfalls, however, if transitioned to operational use, the model can be used to bridge periods when less technical or less experienced personnel fill OCM billets. Models such as this can function initially as a training tool during the job orientation time. The model would assist less experienced officers and reduce training time for a new/incoming action officer.

Verification, Validation, and Accreditation (VV&A)

In general, verification is the process of determining that a model accurately represents the conceptual description and specifications for the problem space. Validation is the process of determining the degree to which a model is an accurate representation of the problem behavior given the intended use of the model. Accreditation is the official determination that a computer model is acceptable for a specific purpose.

The SWO community management model was verified for accuracy by subject matter experts who participated in the model development and are referenced as part of the modeling team. Accreditation of the model is ongoing. No validation was performed.

Results

The model behaves in a reasonable and rational fashion. Subject matter experts conducted detailed expert and technical reviews of the model on multiple occasions. Based on the results of technical reviews, the model represents the effects of manpower policy changes on the mid-grade shortfall (see Figure 4). The graph represents the inventory of mid-grade officers compared to the programmed authorization for mid-grade officers over the simulation run-time of 240 months. At the bottom of each graph, the far left variable represents the variable being measured, and the far right variable represents the dimension of the variable (i.e., Mid-grade ES and People respectively). Each of the following output graphs illustrates how the model responds to variable changes. To derive specific policies, the analyst must develop test scenarios and use the model to experiment in a what-if fashion. Values for variables such as unemployment and losses were chosen as test values. For each graph, notice the difference between inventory (quantity) and requirements.

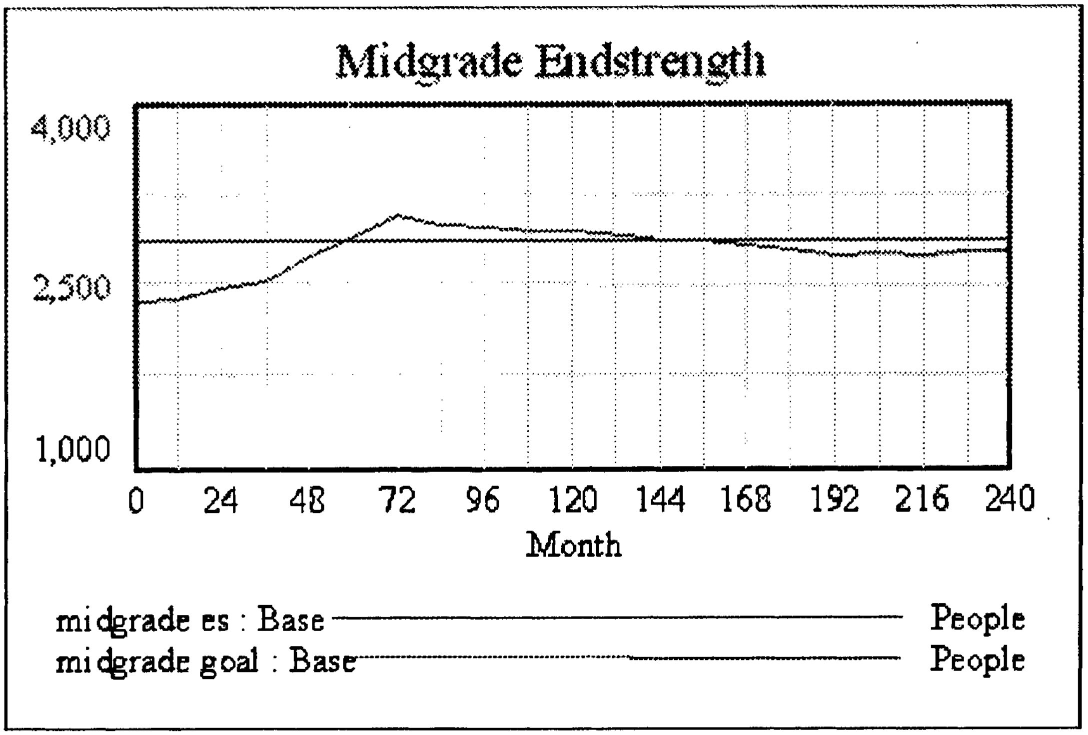


Figure 4. "Mid-grade End-strength."

Figure 5 depicts the model in the base case with a constant requirement for officers and an unemployment rate of five percent. In the base case an unemployment rate of five percent is considered normal and has no effect on the model; if the unemployment rate changes it will affect the model. "Actual manning" represents the actual inventory of SWOs. The graph compares the inventory with the programmed authorization for SWOs (Note: overall the SWO community is over manned, which means there is sufficient inventory, but not at the correct paygrades and year groups. Given the supply chain characteristics of Navy personnel, this is the result of not accessing enough officers to account for losses in future years).

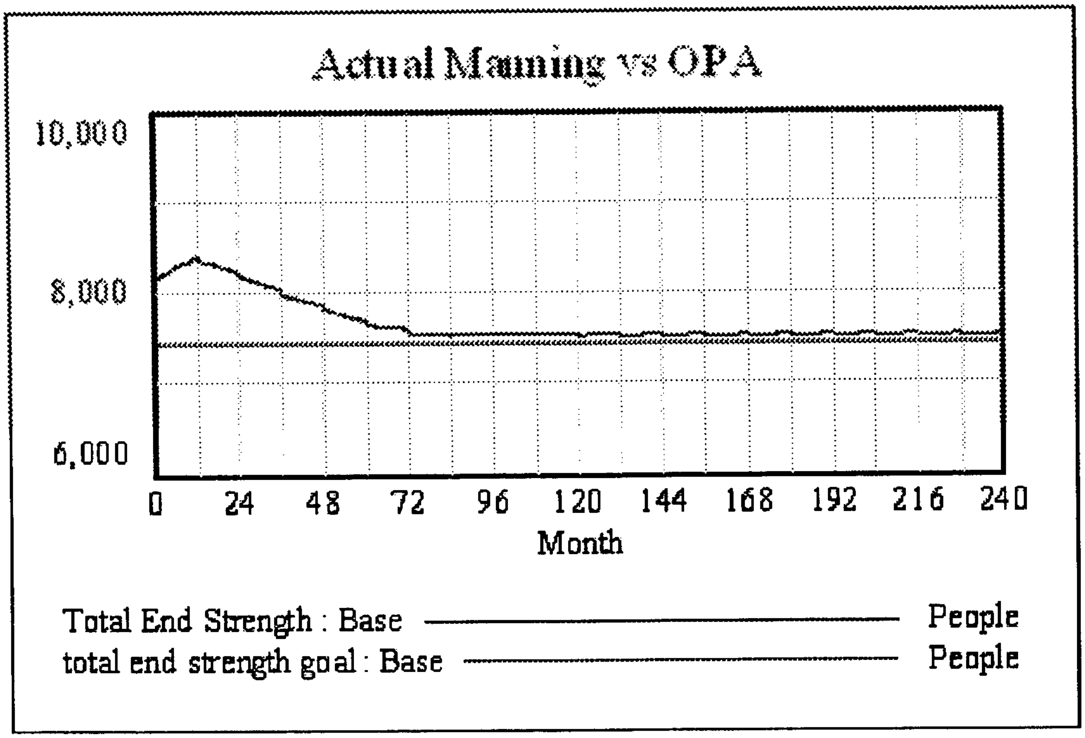


Figure 5. Base with Five Percent Unemployment.

The next business case (model excursion), in Figure 6, shows three years, the results of a programmed authorization increase of five percent per year starting in year 5. Programmed authorizations remain constant until year 15, and then rapidly decrease by fifteen percent. The model follows the changing requirement signal in a deliberate and expected manner. Notice the model lags requirement changes in a realistic fashion.

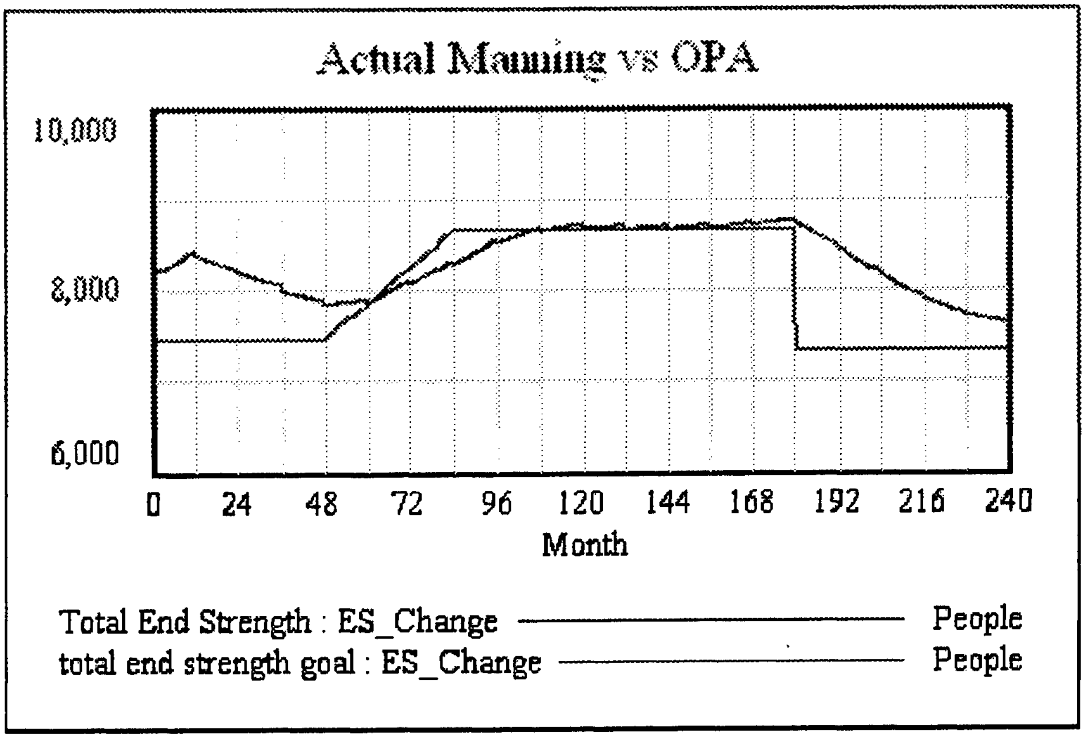


Figure 6. Five Percent Programmed Authorizations Increase.

An experiment was conducted with the model to determine the effect of changes in unemployment rate. The unemployment rate was held steady at 7.5 percent (Figure 7). This is interpreted as unemployment being 2.5 percent greater than normal—which translates to military careers being more attractive.

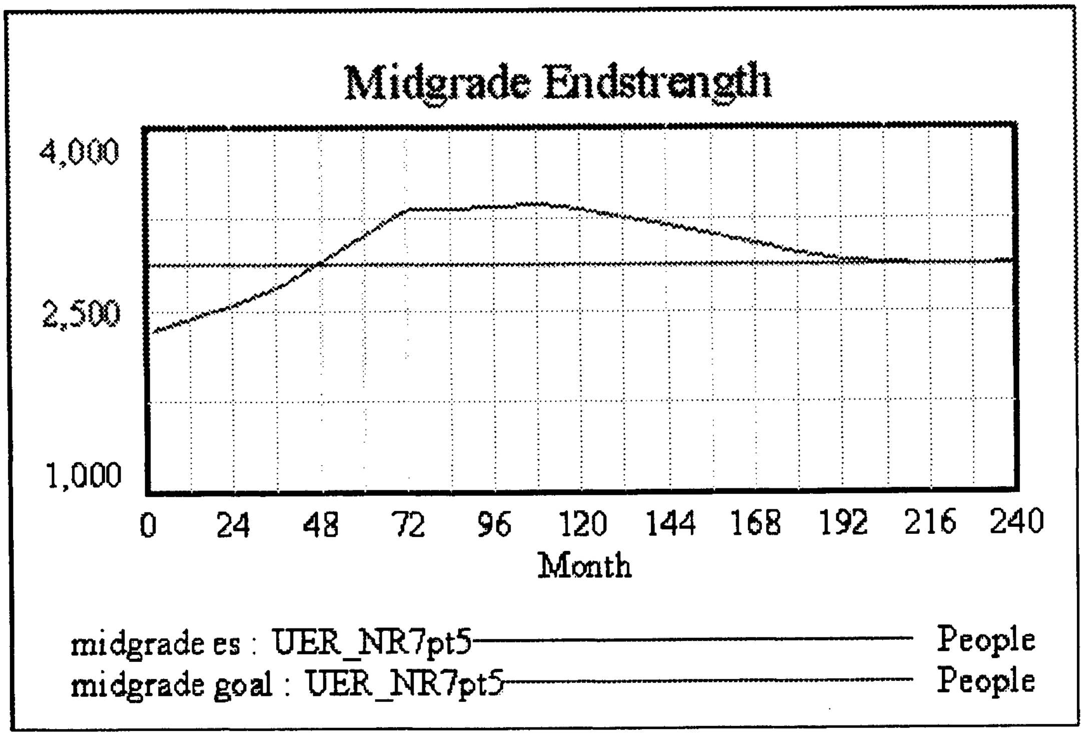


Figure 7. Unemployment Rate at 7.5%.

Another experiment with the model involved the effects of instituting OCP. In this case, we ASSUMED that due to OCP, the resignation rates of age cohorts with 6–9 years of service would be reduced significantly from the norm. Instead of a default 30 percent loss rate per year, the loss rate was reduced to 5 percent per year for those critical year groups (see Figure 8). Note that these results are based on the modeling assumptions and that they are specific to this computer simulation.

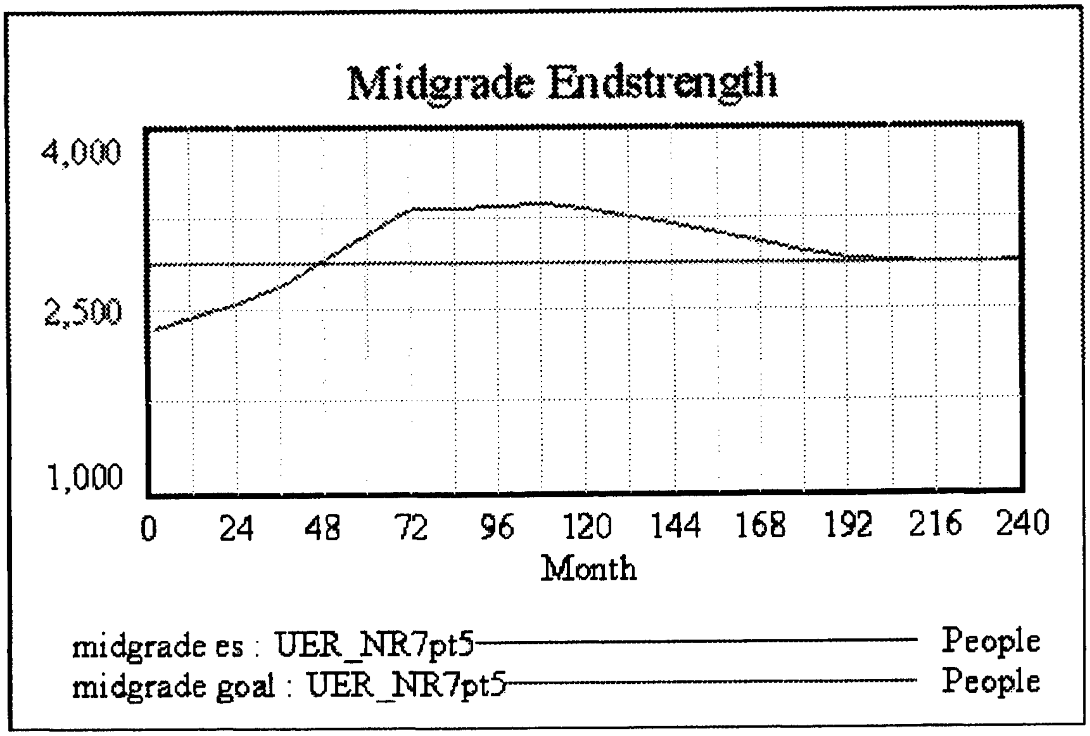


Figure 8. Officer Continuation Pay.

Conclusions

The simulation model provides a valuable view of officer retention behavior that could be useful for determining aggregate effects of manpower policy and business process changes. The model was structured as generically as possible to allow generalization to communities other than SWO.

A working SD model was developed and verified for real-world fidelity in a relatively short period of time; this is a major strength of SD modeling.

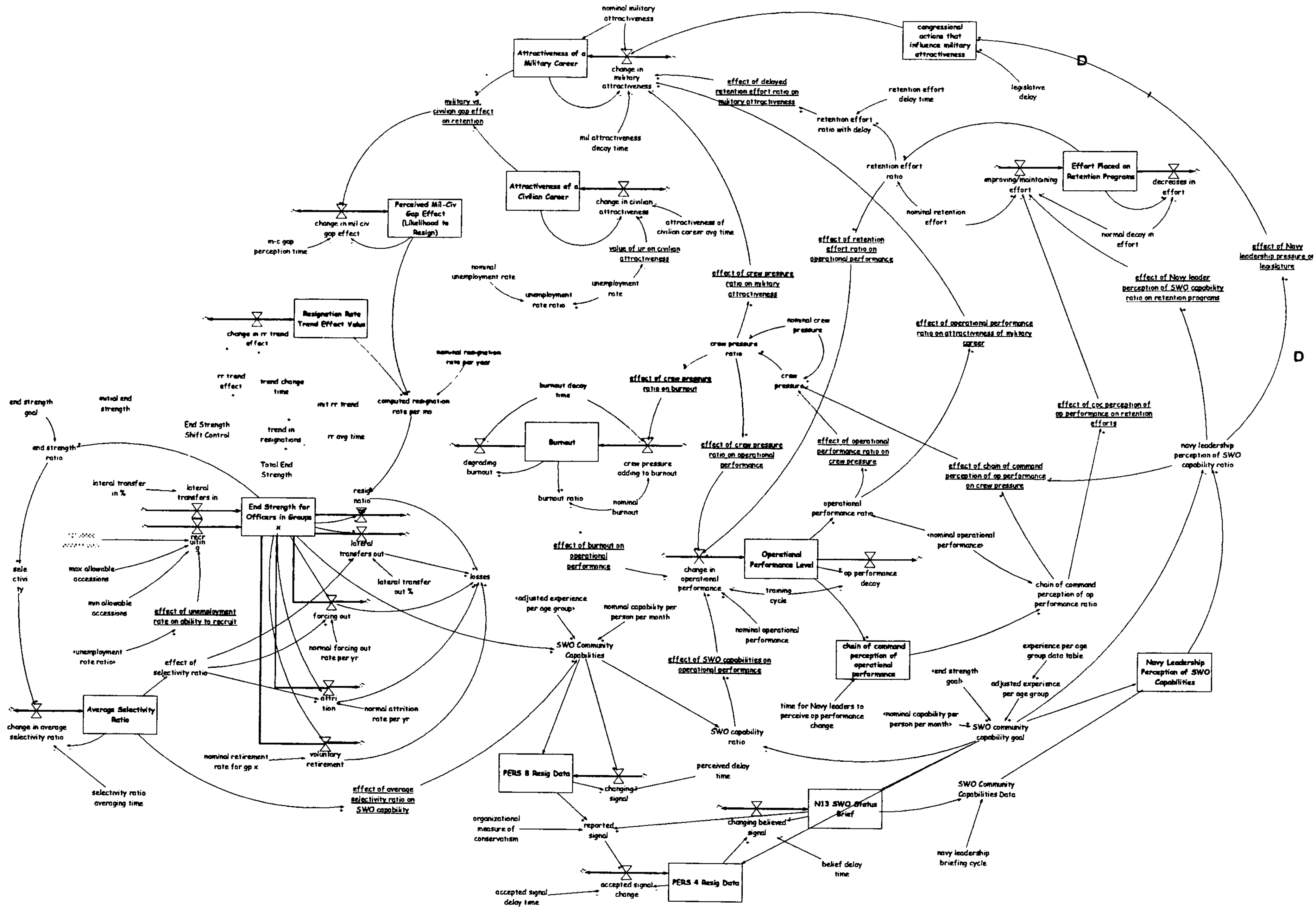
Furthermore, SD is a viable simulation method that enables the development of integrated manpower and personnel models. The primary benefit of this approach is to bridge functional areas and provide direct linkage between policies for both strategic planning and execution.

Recommendations

We recommend SD as a method for developing integrated manpower and personnel computer models in the military M&P area. If this model is to be used for actual strategic planning, it will require a full statistical analysis and results validation using historical officer inventory data and behavior rates. This analysis should be accomplished to ensure that the "as-is" model faithfully replicates SWO community behavior before the model is used for "official" policy analysis and budgetary decisions.

Appendix A
SWO Community Management Model

SWO Community Management Model



Appendix B
Variables

Key: Capitalized "Variables" are *Stocks*. Lowercase "variables" are *flows*.

```
model variable =
        some equation expressed in FUNCTIONS of variables or value in the case of a constant.
        ~       units
        ~       comments/remarks
        |
---------------variables--------------------

accepted signal change=
        (reported signal - PERS 4 Resig Data) / accepted signal delay time
        ~       capability/Month
        ~       The rate at which the accepted signal changes.
        |

accepted signal delay time=
        2
        ~       Month
        ~       The time delay associated with accepting changed data.
        |

Accessions= INTEG (
        +change in accessions, 0)
        ~       People
        ~       The number of people that need to be accessed to make up for gaps and losses|

adjusted experience per age group[years of service]=
        experience per age group data table[years of service] + MODULO(Time, 12)
        ~       Month
        ~       Each age group has a certain no. of months of experience, e.g. ag4 has  between 36
and 48 months of experience depending on the simulation time.  This variable uses the MOD
function to increase the experience age between the SHIFTS, e.g. at TIME=0 ag4 is 36 mos. old.
At time 8 it is 44.  But at TIME=12 (it resets when the SHIFT IF TRUE occurs) and is reset to
back to 36 as the new cohort ages from below.
        |

Attractiveness of a Civilian Career= INTEG (
        +change in civilian attractiveness, 50)
        ~       attractiveness
        ~       Range is 0 to 100. 50 is the nominal setting based on the nominal unemployment
rate.
        |

Attractiveness of a Military Career= INTEG (
        +change in military attractiveness, 40)
        ~       attractiveness
        ~       Range is nominally 0 to 100. Nominal setting is 50.  At initialization, both
military and civilian attractiveness are equal when set to the nominal settings.
        |

attractiveness of civilian career avg time=
        1
        ~       Month
        ~This variable is essentially a unit conversion, but it can be used to adjust for
different rates of change between military and civilian attractiveness.|

attrition[years of service]=
        MAX(End Strength for Officers in Groups x[years of service] *
        (normal attrition rate per yr[years of service]/months per year) *
        effect of selectivity ratio on attrition[years of service],0)
        ~       People/Month
        ~       This flow is the rate of loss to the system for medical, administrative and legal
reasons.  Nominal rates for each age cohort are modified by the effect of selectivity.
        |

Average Pipeline Losses= INTEG (
        +change in losses, 50)
        ~       People/Month
        ~       This variable accounts for changes in the numbers needed to be accessed due to
changes in the loss rates.|
```

```
Average Selectivity Ratio[active service]= INTEG (
	+change in average selectivity ratio[active service], 1)
	~	Dmnl
	~	This stock accumulates the selectivity changes over time as smoothed by an
averaging time, set nominally at 6 months.|

belief delay time=
	2
	~	Month
	~	The time required for the community manager to believe the data being received
from PERS-4 and then to incorporate it into the status brief.
	|

Burnout= INTEG (
	+crew pressure adding to burnout - degrading burnout, 1)
	~	burnout
	~Stock accumulates burnout over time.|

burnout decay time=
	1
	~	Month
	~|

burnout ratio=
	Burnout/nominal burnout
	~	Dmnl
	~|

chain of command perception of op performance ratio=
	chain of command perception of operational performance / nominal operational performance
	~	Dmnl
	~	ratio = actual / goal
	|

chain of command perception of operational performance=
	DELAY N(Operational Performance Level, time for Navy leaders to perceive op performance
change , Operational Performance Level, 6)
	~	ru
	~ There is some delay involved. The chain of command delay is much less than that of the
Navy Leadership.  The Chain of Command represents the COs, Squadron, and Group Commanders that
are on the waterfront and deployed with the forces.|

change in accessions=
	IF THEN ELSE(MODULO(Time, 12)=0, (to access - Accessions)/TIME STEP, 0)
	~	People/Month
	~This value is changed on an annual basis to reflect annual accession plans|

change in average selectivity ratio[active service]=
	(selectivity[active service] - Average Selectivity Ratio[active service])/selectivity
ratio averaging time
	~	1/Month
	~Monthly rate at which selectivity changes.|

change in civilian attractiveness=
	(value of ur on civilian attractiveness - Attractiveness of a Civilian Career) /
attractiveness of civilian career avg time
	~	attractiveness/Month
	~Monthly change in attractiveness|

change in losses=
	(losses - Average Pipeline Losses)/loss averaging time
	~	People/Month/Month
	~Monthly change in loss rate|

change in mil civ gap effect=
	("military vs. civilian gap effect on retention" - "Perceived Mil-Civ Gap Effect
(Likelihood to Resign)" ) / "m-c gap perception time"
	~	1/Month
	~	Monthly change in gap effect on retention as smoothed by perception time.
	|
```

change in military attractiveness=
((nominal military attractiveness/mil attractiveness decay time) *
effect of crew pressure ratio on military attractiveness *
effect of delayed retention effort ratio on military attractiveness *
effect of operational performance ratio on attractiveness of military career *
congressional actions that influence military attractiveness) -
(Attractiveness of a Military Career/mil attractiveness decay time)
~ attractiveness/Month
~ Nominal rate affected by four effect multipliers (crew pressure, retention effort, operational performance and congressional action) and then smoothed by the decay time.|

change in operational performance=
(nominal operational performance/training cycle) *
effect of burnout on operational performance *
effect of crew pressure ratio on operational performance *
effect of SWO capabilities on operational performance *
effect of retention effort ratio on operational performance
~ ru/Month
~ Nominal rate per month of the training cycle as amplified by the effects of burnout, crew pressure, capability and retention effort|

change in rr trend effect[years of service]=
(+rr trend effect[years of service] - Resignation Rate Trend Effect Value[years of service])/trend change time
~ 1/Month
~ Trend effect changes per month smoothed by the trend change time|

changing believed signal=
(PERS 4 Resig Data - N13 SWO Status Brief) / belief delay time
~ capability/Month
~ The difference between what PERS-4 accepts and what the community manager believes smoothed by delay.
|

changing signal=
(SWO Community Capabilities - PERS 8 Resig Data)/perceived delay time
~ capability/Month
~ The rate at which perceptions of the true signal change. We are using community capability as the signal which is a proxy for resignation requests which is the data that PERS-8 actually tracks.
|

"computed resignation rate per mo."[years of service]=
MAX((nominal resignation rate per year[years of service]/months per year) *
"Perceived Mil-Civ Gap Effect (Likelihood to Resign)" *
Resignation Rate Trend Effect Value[years of service],0)
~ 1/Month
~ The nominal resignation rate by age cohort as amplified by the likelihood to resign and the trend effect.|

congressional actions that influence military attractiveness=
DELAY N(effect of Navy leadership pressure on legislature, legislative delay, 1, 6)
~ Dmnl
~ DELAY N(input,delay time, initial value, order) N'th order exponential delay
This is a sixth order exponential delay of the pressure received from the Navy on the Congress to enact legislation favorable to maintaining the system. This could be pay raises, medical benefits, housing, bonuses for continuation or separation, cost of living increases, etc. The effect multiplier is reduced and slowed by legislative delay. |

crew pressure=
nominal crew pressure *
effect of chain of command perception of op performance on crew pressure *
effect of operational performance ratio on crew pressure
~ pressure
~ Crew pressure and retention effort are drawn from the same finite supply of "psychic capital" held by commanders. As operational performance increases, crew pressure can be reduced, but the chain of command is also incrementally adding or subtracting based on a delayed signal.|

```
crew pressure adding to burnout=
	(nominal burnout/burnout decay time) * effect of crew pressure ratio on burnout
	~	burnout/Month
	~	Crew pressure adds to burnout.|

crew pressure ratio=
	crew pressure/nominal crew pressure
	~	Dmnl
	~	ratio = actual / nominal. There is some level of crew pressure which is needed to
get the job done.  The ratio is used to eliminate units from the subsequent effects.
	|

decreases in effort=
	Effort Placed on Retention Programs/normal decay in effort
	~	ret effort/Month
	~	Normal exponential decay.  Retention effort must be continuously maintained and
refreshed to remain effective.
	|

degrading burnout=
	Burnout / burnout decay time
	~	burnout/Month
	~	Crews can recover from burnout, slowly.|

effect of average selectivity ratio on SWO capability= WITH LOOKUP (
	SUM(Average Selectivity Ratio[active service!])/ELMCOUNT(active service), ([(0,0)-
(2,2)],(0,0.5),(2,1.5) ))
	~	Dmnl
	~	Direct linear relationship of selectivity on capability.|

effect of burnout on operational performance= WITH LOOKUP (
	burnout ratio, ([(0,0.4)-
(3,1.25)],(0,1),(1,1),(1.25,0.95),(1.5,0.9),(1.67,0.75),(1.84404,0.667),(
2.1,0.55),(2.5,0.5),(3,0.5) ))
	~	Dmnl
	~	This has a MAJOR effect on operational performance. Knee-point setting around 0.67
is crucial to tune model to stay in balance.
	|

effect of chain of command perception of op performance on crew pressure= WITH LOOKUP  (
	chain of command perception of op performance ratio,
([(0,1)-(2,1.5)],(0,1.5),(0.477064,1.42105),(0.593272,1.39474),(0.70948,1.35088),(0.740061
,1.25439),(0.801223,1.14035),(0.905199,1.04386),(1,1),(2,1),(5,1) ))
	~	Dmnl
	~	As the ratio increases above nominal (1.0), crew pressure is eased - as the ratio
drops below nominal (<1.0) crew pressure ramps up sharply.|

effect of coc perception of op performance on retention efforts= WITH LOOKUP (
	chain of command perception of op performance ratio, ([(0,0)-
(2,2)],(0,0),(0.244648,0.0701754),(0.385321,0.140351),(0.53211,0.245614),(0.66055
,0.385965),(0.788991,0.54386),(0.892966,0.719298),(0.948012,0.859649),(1,1),(1.06422
,1.15789),(1.16208,1.31579),(1.36391,1.42982),(1.52905,1.47368),(1.8104,1.5),(2,1.5 ) ))
	~	Dmnl
	~	As the ratio increases above nominal (1.0), More effort is devoted to retention -
as the ratio drops below nominal (<1.0) effort on retention drops.|

effect of crew pressure ratio on burnout= WITH LOOKUP (
	crew pressure ratio, ([(0,0)-
(6,2)],(0,0),(0.385321,0.289474),(0.825688,0.719298),(1,1),(1.05199,1.13158
),(1.12538,1.37719),(1.26605,1.58772),(1.3211,1.69298),(1.44343,1.78947),(1.64526,1.92105
),(1.79205,1.9386),(2,1.94737),(5,2) ))
	~	Dmnl
	~	As the ratio increases above nominal (1.0), burnout increases.|

effect of crew pressure ratio on military attractiveness= WITH LOOKUP (
	crew pressure ratio, ([(0,0)-(4,4)],(0,0),(2,2),(4,4) ))
	~	Dmnl
	~	Command Climate and working conditions are implicit in this effect. As the crew
pressure goes up, job satisfaction and the attractiveness of a military career go down.
	|
```

```
effect of crew pressure ratio on operational performance= WITH LOOKUP (
	crew pressure ratio, ([(0,0)-
(6,2)],(0,1),(1,1),(1.0948,1.30702),(1.21713,1.42982),(1.44343,1.46491),(2, 1.5),(5,1.5) ))
	~	Dmnl
	~	Very steep initial effect. An increase in work hours has an almost immediate
effect on performance but is limited very quickly by the law of diminishing returns.\!\!
	|

effect of delayed retention effort ratio on military attractiveness= WITH LOOKUP (
	retention effort ratio with delay, ([(0,0)-
(2,2)],(0,0),(0.342508,0.0701754),(0.629969,0.254386),(0.83792,0.587719),(1
,1),(1.14373,1.44737),(1.3578,1.76316),(1.59633,1.92982),(2,2) ))
	~	Dmnl
	~	Increased retention efforts increase military attractiveness|

effect of Navy leader perception of SWO capability ratio on retention programs= WITH LOOKUP  (
	navy leadership perception of SWO capability ratio, ([(0,0)-
(4,2)],(0,2),(0.140673,1.94737),(0.256881,1.89474),(0.415902,1.82456),(0.550459
,1.76316),(0.70948,1.64912),(0.83792,1.51754),(0.93578,1.26316),(1,1),(1.25382,0.929825
),(1.48012,0.868421),(4,0) ))
	~	Dmnl
	~	CDR Peterson "kentucky windage". If the capability exceeds the requirement (ratio
>1) then the retention effort eases off gradually. But should capability drop, then retention
effort is ramped up sharply.
	|

effect of Navy leadership pressure on legislature= WITH LOOKUP (
	navy leadership perception of SWO capability ratio, ([(0,0)-(4,2)],
(0,2),(0.287462,1.99123),(0.40367,1.97368),(0.507645,1.90351),(0.587156
,1.81579),(0.636086,1.63158),(0.691131,1.39474),(0.746177,1.13158),(0.819572,1.03509
),(1,1),(1.24771,0.921053),(1.95719,0.72807),(2.31193,0.631579),(2.88685,0.45614),(
3.6208,0.166667),(4,0) ))
	~	Dmnl
	~	CDR Peterson SWO curve - maybe different for aviation. As Capability increases
above the requirement (ratio > 1) pressure eases, but should capability decrease then the
pressure on Congress increases slowly at first then sharply.
	|

effect of operational performance ratio on attractiveness of military career= WITH LOOKUP  (
	operational performance ratio, ([(0,0)-(2,2)],
(0,0),(0.48318,0.105263),(0.623853,0.307018),(0.721713,0.614035),(0.752294
,0.77193),(0.819572,0.894737),(1,1),(1.18654,1.14912),(1.44343,1.49123),(1.60856,1.68421
),(1.72477,1.81579),(2,2) ))
	~	Dmnl
	~	Implicit in this effect is job satisfaction. As doing a good job goes up as
measured by operational performance, job satisfaction increases thus increasing attractiveness of
a military career.
	|

effect of operational performance ratio on crew pressure= WITH LOOKUP (
	operational performance ratio,
([(0,1)-(2,2)],(0.0183486,1.96491),(1.00306,1.5),(2,1.5) ) )
	~	Dmnl
	~	As operational performance increases above requirement, crew pressure is reduced -
as performance drops below required, crew pressure increases.
	|

effect of retention effort ratio on operational performance= WITH LOOKUP (
	retention effort ratio, ([(0,0)-(2,2)],
(0,1),(1,1),(1.29664,0.912281),(1.5,0.75),(1.66361,0.552632),(1.84098
,0.403509),(1.97554,0.385965) ))
	~	Dmnl
	~	As retention effort increases above nominal, operational performance is slowly
degraded since less energy is available for operational issues. As the ratio decreases below 1.0,
there is no effect on operational performance.|

effect of selectivity ratio[active service]=
	Average Selectivity Ratio [active service]~~|
effect of selectivity ratio[Mandatory Retirement]=
	0
```

```
        ~       Dmnl
        ~       Selectivity ratio increases or decreases by Years of Service cohorts by
multiplication forcing out, lateral transfers out and attrition|

effect of SWO capabilities on operational performance= WITH LOOKUP (
        SWO capability ratio, ([(0,0)-
(5,2)],(0,0.5),(0.397554,0.526316),(0.495413,0.578947),(1,1),(1.98777,1.91228
),(2.35474,1.95614),(10,2) ))
        ~       Dmnl
        ~       As capability goes up, performance increases. |

effect of unemployment rate on ability to recruit= WITH LOOKUP (
        unemployment rate ratio, ([(0,0)-
(2,1)],(0.397554,0.368421),(0.495413,0.609649),(0.623853,0.79386),(0.782875
,0.916667),(1,1),(2,1) ))
        ~       Dmnl
        ~       Restricts the ability to recruit if the ratio goes below nominal, i.e. as
unemployment rate decreases below the nominal unemployment rate.|

Effort Placed on Retention Programs= INTEG (
        +"improving/maintaining effort" - decreases in effort, 50)
        ~       ret effort
        ~       Accumulates and stores retention effort over time|

End Strength for Officers in Groups x[ag0]= INTEG (
        recruiting -
        attrition[ag0] -
        forcing out[ag0] -
        voluntary retirement[ag0] -
        resignations[ag0] -
        lateral transfers out[ag0],
        initial end strength[ag0])
        ~       People
        ~       Stores first year transactions.|

End Strength for Officers in Groups x[experienced]= INTEG (
        lateral transfers in[experienced] -
        attrition[experienced] -
        forcing out[experienced] -
        resignations[experienced] -
        voluntary retirement[experienced] -
        lateral transfers out[experienced],
        initial end strength[experienced])
        ~       People
        ~       Contains years of service cohorts from ag1 to mandatory retirement.   |

end strength goal[ag29-ag0]:=
        GET XLS DATA( 'Officer End strength Data.xls'  ,'Sheet2' , 'B', 'AE11:C11') ~~|
end strength goal[Mandatory Retirement]=
        End Strength for Officers in Groups x[Mandatory Retirement]
        ~
        ~       Note: syntax for GET XLS DATA( {'filename'} , {'tabname'} , {'time_row_or_col'} ,
{'first_data_cell'} )  Gets data from spreadsheet.  See spreadsheet to vary time series data for
end strength.  This is the OPA by age cohort.  Initial data as of NOV 2000 obtained from N131W.
        |

end strength ratio[active service]=
        ZIDZ(End Strength for Officers in Groups x[active service], end strength goal[active
service ])
        ~       Dmnl
        ~       ratio = actual / goal
        |

End Strength Shift Control=
        SHIFT IF TRUE(End Strength for Officers in Groups x[ag0], MODULO(Time, 12)=0,
        Mandatory Retirement, 0, 0)
        ~       People
        ~       The "SHIFT IF TRUE" function is used to "age" the population.  Every 12 months,
each cohort is shifted down.  ag29 replaces Mandatory Retirement.   SHIFT IF TRUE( {vector} ,
{cond} , {nelm} , {accum} , {incoming} )
```

```
	~	:SUPPLEMENTARY
	|

es gap oh now vs future goal[active service]=
	GET DATA AT TIME(end strength goal[active service],INTEGER(Time + 12)) - End Strength for
Officers in Groups x [active service]
	~	People
	~	GET DATA AT TIME(end strength goal lookup, INTEGER(Time/12) + 12) This allows the
model to look ahead one year to the goal.
	|

experience per age group data table[years of service]=
	GET XLS CONSTANTS( 'Officer End strength Data.xls', 'Sheet2', 'B7'  )
	~	Month
	~|

FINAL TIME  = 240
	~	Month
	~	The final time for the simulation.
	|

forcing out[years of service]=
	MAX(End Strength for Officers in Groups x[years of service] *
	normal forcing out rate per yr[years of service]/months per year *
	effect of selectivity ratio on forcing out[years of service],0)
	~	People/Month
	~	Selectivity increases or reduces this rate to explicitly model "fail of Selection
(FOS) or in other words the "up or out" rate.  Promotion is then implicitly included in this
variable.
|
"improving/maintaining effort"=
	(nominal retention effort/normal decay in effort) *
	effect of Navy leader perception of SWO capability ratio on retention programs *
	effect of coc perception of op performance on retention efforts
	~	ret effort/Month
	~	Retention effort requires continuous energy.|

init rr trend=
	0
	~	1/Month
	~	Initial trend set at zero for the slope or first derivative of resignation rate.|

initial end strength[ag29-ag0]=
	GET XLS CONSTANTS( 'Officer End strength Data.xls'  ,'Sheet1'  , 'AE8:C8') ~~|
initial end strength[Mandatory Retirement]=
	0
	~	People
	~	Get data from spreadsheet by cohort for initialization|

INITIAL TIME  = 0
	~	Month
	~	The initial time for the simulation.
	|

lateral transfers in[experienced]=
	End Strength for Officers in Groups x[experienced] *
	"lateral transfer in %"[experienced]/months per year
	~	People/Month
	~	Used to gain accessions by cohort from other communities like aviation or nuclear
power school.  Most transfers in occur during first three years.|

"lateral transfer in %"[ag29-ag1]=
	GET XLS CONSTANTS( 'Officer End strength Data.xls'  ,'Sheet1'  , 'AE42:D42') ~~|
"lateral transfer in %"[Mandatory Retirement]=
	GET XLS CONSTANTS( 'Officer End strength Data.xls'  ,'Sheet1'  , 'AF42')
	~	1/Year
	~	Get data from spreadsheet by cohort. |

"lateral transfer out %"[ag29-ag0]=
	GET XLS CONSTANTS( 'Officer End strength Data.xls'  ,'Sheet1'  , 'AE43:C43') ~~|
```

```
"lateral transfer out %"[Mandatory Retirement]=
        GET XLS CONSTANTS( 'Officer End strength Data.xls'  ,'Sheet1'  , 'AF43')
        ~       1/Year
        ~       Get data from spreadsheet by cohort. |

lateral transfers out[years of service]=
        MAX(End Strength for Officers in Groups x[years of service] ("lateral transfer out %"
[years of service]/months per year) * effect of selectivity ratio,0)
        ~       People/Month
        ~       Selectivity acts on the nominal rate - modeling the community manager's decision
to allow transfers out of the community even during periods of reduced end strength.|

legislative delay=
        12
        ~       Month
        ~       This very significant delay arises when forwarding initiatives from the Navy
through the Executive and legislative branches of the government until legislation is enacted. |

loss averaging time=
        6
        ~       Month
        ~       Smoothing and unit conversion|

losses=
        SUM(attrition[years of service!]) + SUM(forcing out[years of service!])
        + SUM(resignations[years of service!]) + SUM(voluntary retirement[years of service!]) +
        SUM(lateral transfers out[years of service!])
        ~       People/Month
        ~       Sum of all losses for calculation of needed accessions.|

"m-c gap perception time"=
        3
        ~       Month
        ~       Time to perceive a change in the gap - smoothing time.|

max allowable accessions=
        1100
        ~       People/Year
        ~       1100 is the maximum limit on accessions set by N131B. In terms of percent of OPA
the percent would be 13.75% - |

midgrade es=
        SUM(End Strength for Officers in Groups x[Midgrade!])
        ~       People
        ~       Sums midgrade endstrength for year of service cohorts ag6-ag15
        |

midgrade gap=SAMPLE IF TRUE(
        IF THEN ELSE( MODULO(Time, 12)=0, 0,1) = 0 , midgrade goal-midgrade es, 852.067)
        ~       People
        ~       Graph variable to show year start value of Gap. Uses sample if true to  remove
sawtooths in data. uses SAMPLE IF TRUE( IF THEN ELSE( MODULO(Time,  12)=0, 0,1) = 0 , midgrade
goal-midgrade es, 0)
        |

midgrade goal=
        SUM(end strength goal[Midgrade!])
        ~       People
        ~       Sums goal for age cohorts by migrade range (6-15 years of service)
        |

mil attractiveness decay time=
        6
        ~       Month
        ~       Attractiveness slowly decays without constant pressure.|

"military vs. civilian gap effect on retention"=
        Attractiveness of a Military Career*unit conv -
        (Attractiveness of a Military Career*unit conv - Attractiveness of a Civilian Career /
        SQRT(Attractiveness of a Military Career * Attractiveness of a Civilian Career))
```

```
        ~       Dmnl
        ~       gap = mil - civ.  By definition the gap range is -100 to +100.
        |
min allowable accessions=
        700
        ~       People/Year
        ~       700 accessions per year set as the minimum acceptable limit by N131B. In terms of
OPA the minimum accessions should not be less than 8.75% of OPA|

months per year=
        12
        ~       Month/Year
        ~|      Unit conversion

N13 SWO Status Brief= INTEG (
        +changing believed signal, SWO community capability goal)
        ~       capability
        ~       The signal actually being used by people in the field (recruiting, detailers,
training command.)  The delays associated with believing the accepted signal involve confidence
in the data sources and  include verification by action officers and other staff work delays.
        |

navy leadership briefing cycle=
        6
        ~       Month
        ~       SWOFOC Annual or SWCC cycle every 6 months [SWO Flag Officer Conference/Surface
Warfare Commanders Conference].
        |

Navy Leadership Perception of SWO Capabilities=SAMPLE IF TRUE(
        SWO Community Capabilities Data>0, SWO Community Capabilities Data, SWO community
capability goal )
        ~       capability
        ~       Using SAMPLE IF TRUE - Values remain constant until next briefing update.|

navy leadership perception of SWO capability ratio=
        Navy Leadership Perception of SWO Capabilities/SWO community capability goal
        ~       Dmnl
        ~       ratio = actual / goal
        |

"no. of months in accession cycle"=
        24
        ~       Month
        ~       12 months to assess plus 12 months to sense/plan for next year.  In fact the cycle
is longer if you take into account the four-year supply chain for the Naval Academy and Enlisted
Commissioning programs.  ROTC has a shorter supply cycle and OCS has the shortest.
        |

nominal burnout=
        1
        ~       burnout
        ~       Constructive variable|

nominal capability per person per month=
        1
        ~       capability/(People*Month)
        ~       Primarily a unit conversion, defined by default as 1 unit of capability per person
per month.  In fact, officer capability is variable, but in the aggregate will be fairly
constant. See selectivity effects on capability.

nominal crew pressure=
        1
        ~       pressure
        ~       Constructive variable|

nominal military attractiveness=
        50
        ~       attractiveness
        ~       Set at 50 and it corresponds to the nominal unemployment rate of 5%|
```

```
nominal operational performance=
        85
        ~       ru
        ~       85 is defined as nominal on a scale from 0 to 100. This is comparable to SORTS
reporting thresholds.
        |

nominal resignation rate per year[ag29-ag0]=
        GET XLS CONSTANTS( 'Officer End strength Data.xls'  ,'Sheet1'  , 'AE41:C41') ~~|
nominal resignation rate per year[Mandatory Retirement]=
        GET XLS CONSTANTS( 'Officer End strength Data.xls'  ,'Sheet1'  , 'AF41')
        ~       1/Year
        ~       Gets data from spreadsheet. Nominal rate by YCS age cohort \
                Data can be converted to a time series for validation using historical data.|

nominal retention effort=
        50
        ~       ret effort
        ~       Nominal is 50 on a scale of 0 to 100.
        |

nominal retirement rate for gp x[ag29-ag0]=
        GET XLS CONSTANTS( 'Officer End strength Data.xls'  ,'Sheet1'  , 'AE40:C40') ~~|
nominal retirement rate for gp x[Mandatory Retirement]=
        GET XLS CONSTANTS( 'Officer End strength Data.xls'  ,'Sheet1'  , 'AF40')
        ~       1/Year
        ~       Gets data from spreadsheet. Nominal rate by YCS age cohort \
                Data can be converted to a time series for validation using historical data.|

nominal unemployment rate=
        0.05
        ~       Dmnl
        ~       Set at 5% and matched to Civilian Attractiveness nominal value of 50.  \
                See unemployment rate effect graph as well..|

normal attrition rate per yr[ag29-ag0]=
        GET XLS CONSTANTS( 'Officer End strength Data.xls'  ,'Sheet1'  , 'AE39:C39') ~~|
normal attrition rate per yr[Mandatory Retirement]=
        0
        ~       1/Year
        ~       Gets data from spreadsheet. Nominal rate by YCS age cohort \
                Data can be converted to a time series for validation using historical data.|

normal decay in effort=
        2
        ~       Month
        ~       Retention effort is good for 60 days|

normal forcing out rate per yr[ag29-ag0]=
        GET XLS CONSTANTS( 'Officer End strength Data.xls'  ,'Sheet1'  , 'AE38:C38') ~~|
normal forcing out rate per yr[Mandatory Retirement]=
        0
        ~       1/Year
        ~ Gets data from spreadsheet. Nominal rate by YCS age cohort \
                Data can be converted to a time series for validation using historical data.|

op performance decay=
        Operational Performance Level/training cycle
        ~       ru/Month
        ~       Based on the length of the training cycle.  An increase in the training cycle
reduces the pressure on the crew and allows accomplishment to remain in the system longer.  This
has a positive effect on military attractiveness.|

Operational Performance Level= INTEG (
        +change in operational performance - op performance decay, 80)
        ~       ru
        ~       Scale 0 - 100, 85 is nominal. Proxy for "Readiness". 85 equates to high "C2" or
low "C1".
        |
```

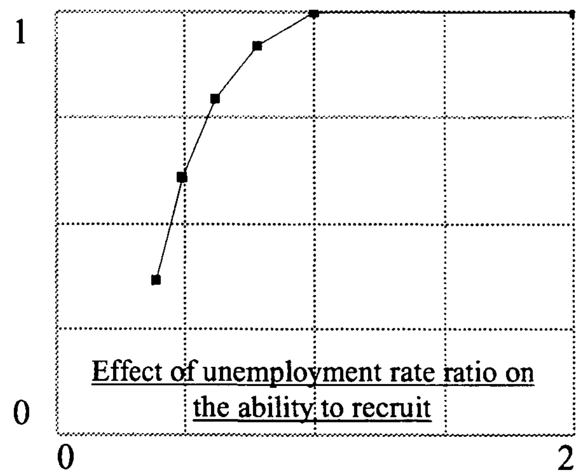
```
operational performance ratio=
	Operational Performance Level/nominal operational performance
	~	Dmnl
	~	ratio = actual / goal
	|

organizational measure of conservatism=
	0.5
	~	Dmnl
	~	The degree to which the organization relies on "tradition" as opposed to new
perceptions.  To a degree, this represents management's measure of confidence in goal reporting
methods.
	|

perceived delay time=
	1
	~	Month
	~	The time required for the "perceiving organization" to recognize a change in the
"true signal."  This time accounts for reporting delays as well as noise and errors in the
reporting.
	|

"Perceived Mil-Civ Gap Effect (Likelihood to Resign)"= INTEG (
	+change in mil civ gap effect, 1)
	~	Dmnl
	~	Stock accumulates the change in the gap effect and is a measure of the likelihood
to resign.  This effect is Navy-wide and NOT disaggregated by years of service.|

PERS 4 Resig Data= INTEG (
	+accepted signal change, SWO community capability goal)
	~	capability
	~	The level that is accepted by the detailers as being true and is used by them to
make decisions.
	|

PERS 8 Resig Data= INTEG (
	+changing signal, SWO Community Capabilities)
	~	capability
	~	The perceived value of the true signal.
	|

planned accessions=
	Accessions/"no. of months in accession cycle"
	~	People/Month
	~	Number of accessions needed per month|

recruiting=
	MAX(MIN(effect of unemployment rate on ability to recruit * planned accessions + IF THEN
ELSE (Time <=12, 83.3,0), (max allowable accessions
	 / months per year)
	), min allowable accessions / months per year)
	~	People/Month
	~	This is the number of officers that the system can access.  It is constrained by a
maximum and a minimum as well as by unemployment rate (an external variable).
	|

reported signal=
	(N13 SWO Status Brief * organizational measure of conservatism) +
	(PERS 8 Resig Data * (1 - organizational measure of conservatism))
	~	capability
	~	The weighted average of the perceived signal and the expected value. The expected
signal is the latest N13 SWO status brief. The perceived signal is the latest PERS 8 resignation
data as tempered by the organizational measure of conservatism.  If the OMC is .5 then the
reported signal will be the average of the two inputs.
	|

Resignation Rate Trend Effect Value[years of service]= INTEG (
	+change in rr trend effect[years of service], 1)
	~	Dmnl
	~	Flywheel effect amplifies change in the same direction|
```

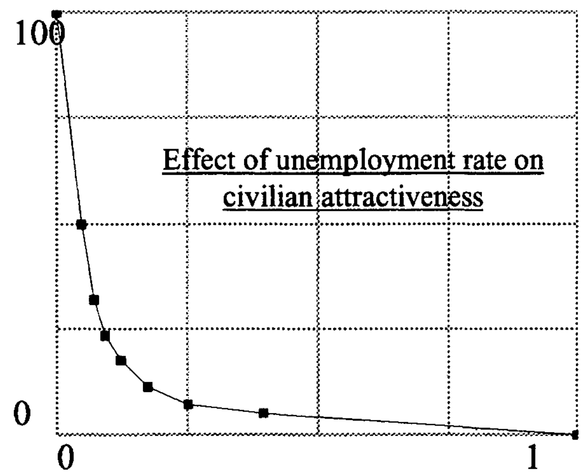
```
resignations[years of service]=
	MAX(End Strength for Officers in Groups x[years of service] * "computed resignation rate
per mo." [years of service],0)
	~	People/Month
	~	resignation rate by cohort, prevented from going negative.|

retention effort delay time=
	6
	~	Month
	~|

retention effort ratio=
	Effort Placed on Retention Programs/nominal retention effort
	~	Dmnl
	~|

retention effort ratio with delay=


	DELAY N(retention effort ratio, retention effort delay time, 1, 6)
	~	Dmnl
	~|

rr avg time=
	3
	~	Month
	~|

rr trend effect[years of service]= WITH LOOKUP (
	trend in resignations[years of service], ([(-1000,0)-(1000,2.5)],(-
1000,0.5),(0,1),(1000,1.5) ))
	~	Dmnl
	~|

SAVEPER  =
	 TIME STEP
	~	Month
	~	The frequency with which output is stored.
	|

selectivity[active service]=
	end strength ratio[active service]
	~	Dmnl
	~	The sum of all the year gap ratios divided by the number of years being  summed.
= the average gap
	|

selectivity ratio averaging time=
	6
	~	Month
	~|

SWO capability ratio=
	SWO Community Capabilities/SWO community capability goal
	~	Dmnl
	~	ratio = actual / goal
	|

SWO Community Capabilities=
	SUM(End Strength for Officers in Groups x[active service!] *
	adjusted experience per age group[years of service!]) *
	effect of average selectivity ratio on SWO capability *
	nominal capability per person per month
	~	capability
	~	Each standard (quality) person generates one unit of capability per month of their
age (experience) adjusted by selectivity effect.  e.g. 100 standard people  (no selectivity
effect) averaging two years (24 mos.) in age, generate  2400 units of capability.
	|
```

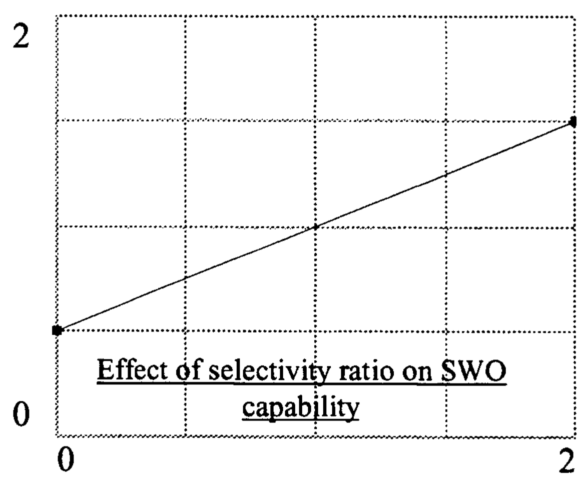
```
SWO Community Capabilities Data=
        IF THEN ELSE( MODULO(Time, navy leadership briefing cycle) = 0,
          N13 SWO Status Brief, 0)
        ~       capability
        ~       IF THEN ELSE( MODULO(sample interval, sensing delay) = 0, Believed Signal,  0)
        |

SWO community capability goal=
        SUM(end strength goal[active service!] * adjusted experience per age group[years of
service !]) * nominal capability per person per month
        ~       capability
        ~|

time for Navy leaders to perceive op performance change=
        1.5
        ~       Month
        ~|

TIME STEP  = 0.125
        ~       Month
        ~       The time step for the simulation.
        |

to access=
        MAX(SUM(es gap oh now vs future goal[active service!]) + (Average Pipeline Losses *  "no.
of months in accession cycle"), 0)
        ~       People
        ~|

Total End Strength=
        SUM(End Strength for Officers in Groups x[active service!])
        ~       People
        ~               ~       :SUPPLEMENTARY
        |

total end strength goal=
        SUM(end strength goal[active service!])
        ~       People
        ~|

training cycle=
        20
        ~       Month
        ~       20 is average number of months across the force estimated by CDR Peterson.
        |

trend change time=
        1
        ~       Month
        ~|

trend in resignations[active service]=
        TREND(resignations[active service], rr avg time, init rr trend) ~~|
trend in resignations[Mandatory Retirement]=
        0
        ~       1/Month
        ~|

unemployment rate= WITH LOOKUP (
        Time, ([(0,0)-(241,0.1)],(0,0.05),(59.75,0.05),(60,0.05),(180,0.05),(241,0.05) ))
        ~       Dmnl
        ~|

unemployment rate ratio=
        unemployment rate/nominal unemployment rate
        ~       Dmnl
        ~|
```

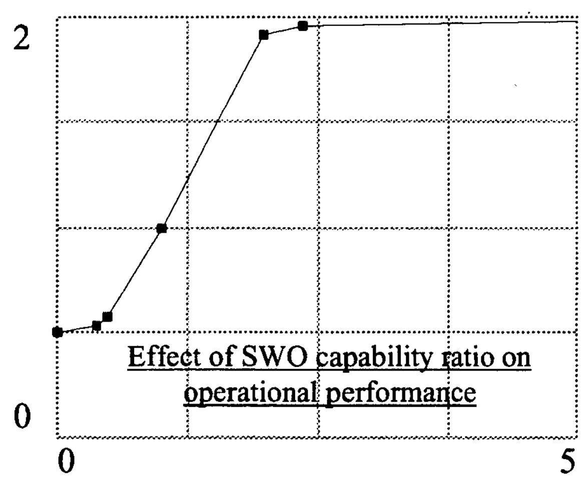
```
unit conv=
        1
        ~       1/attractiveness
        ~|

value of ur on civilian attractiveness= WITH LOOKUP (
        unemployment rate, ([(0,0)-
(1,100)],(0,100),(0.05,50),(0.0733945,32.0175),(0.0948012,23.6842),(0.125382
,17.5439),(0.174312,11.4035),(0.253823,7.01754),(0.397554,4.82456),(1,0) ))
        ~       attractiveness
        ~       This graph is set with the nominal value of 50 being set to the nominal
unemployment rate of 5%.  |

voluntary retirement[years of service]=
        MAX(End Strength for Officers in Groups x[years of service]
        * nominal retirement rate for gp x[years of service] / months per year,0)
        ~       People/Month
        ~This variable kicks in at 20 years of service, unless policy changes allow early
retirement. Modify the spreadsheet rates to change policy settings.|

------------------subscripts----------------

years of service:
ag0,ag1,ag2,ag3,ag4,ag5,ag6,ag7,ag8,ag9,ag10,ag11,ag12,ag13,ag14,ag15,ag16,ag17,ag18
,ag19,ag20,ag21,ag22,ag23,ag24,ag25,ag26,ag27,ag28,ag29,Mandatory Retirement
        ~
        ~|

------------------subscript ranges---------------------

active service:
ag0,ag1,ag2,ag3,ag4,ag5,ag6,ag7,ag8,ag9,ag10,ag11,ag12,ag13,ag14,ag15,ag16,ag17,ag18
,ag19,ag20,ag21,ag22,ag23,ag24,ag25,ag26,ag27,ag28,ag29
        ~
        ~|

active service less ag0:
ag1,ag2,ag3,ag4,ag5,ag6,ag7,ag8,ag9,ag10,ag11,ag12,ag13,ag14,ag15,ag16,ag17,ag18,ag19
,ag20,ag21,ag22,ag23,ag24,ag25,ag26,ag27,ag28,ag29
        ~
        ~|

experienced:
ag1,ag2,ag3,ag4,ag5,ag6,ag7,ag8,ag9,ag10,ag11,ag12,ag13,ag14,ag15,ag16,ag17,ag18,ag19
,ag20,ag21,ag22,ag23,ag24,ag25,ag26,ag27,ag28,ag29,Mandatory Retirement
        ~
        ~|
Midgrade:
        ag10, ag11,ag12,ag13,ag14,ag15,ag6,ag7,ag8,ag9
        ~
        ~Years or Service ag6 - ag15 or LT and LCDR |
```

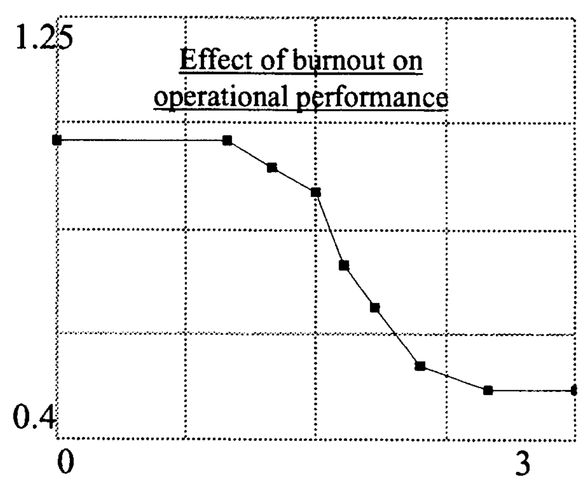
Appendix C
Effect Graphs

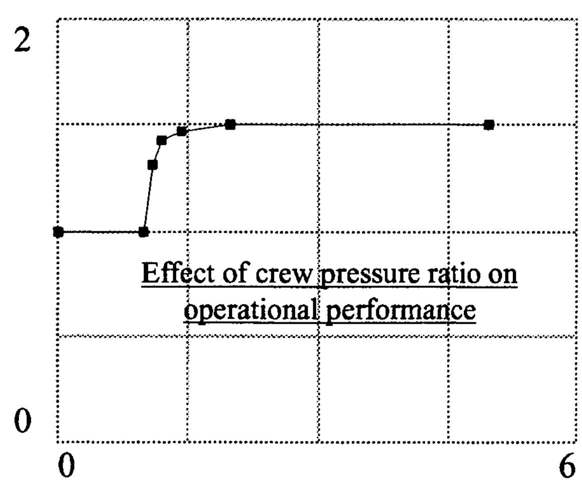

1
0
Effect of unemployment rate ratio on the ability to recruit
0
2

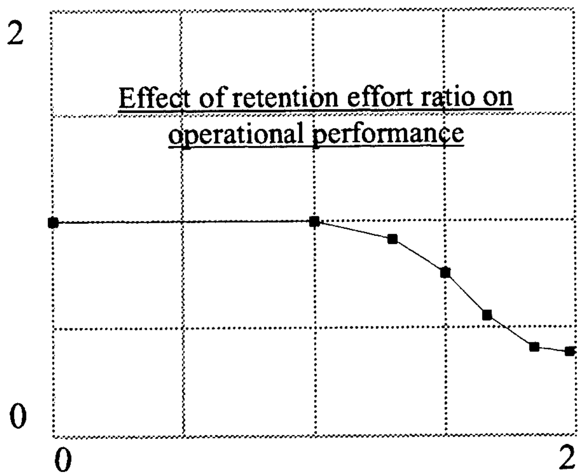

100
0
Effect of unemployment rate on civilian attractiveness
0
1

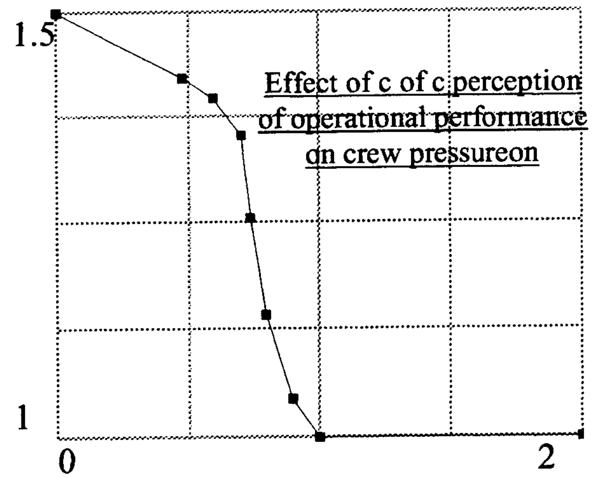

2
0
Effect of selectivity ratio on SWO capability
0
2

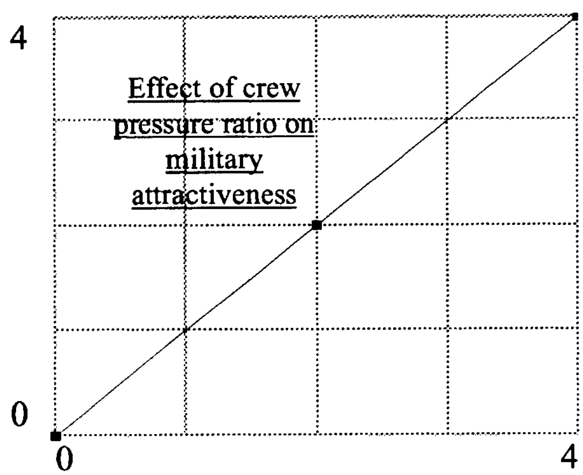

2
0
Effect of SWO capability ratio on operational performance
0
5

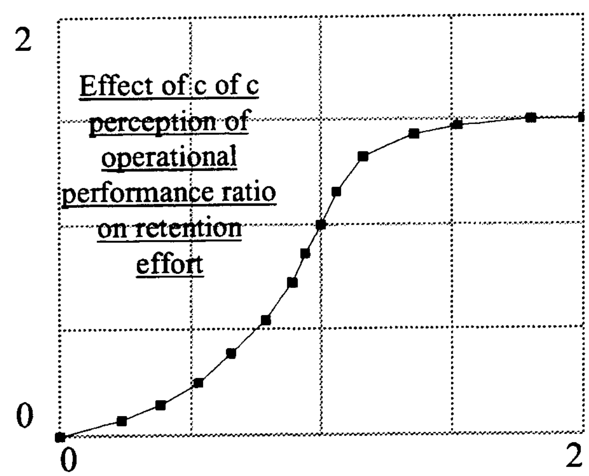

1.25
0.4
Effect of burnout on operational performance
0
3

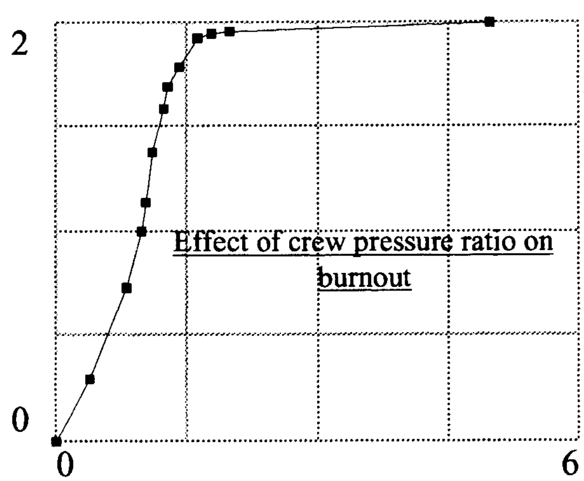

2
0
Effect of crew pressure ratio on operational performance
0
6

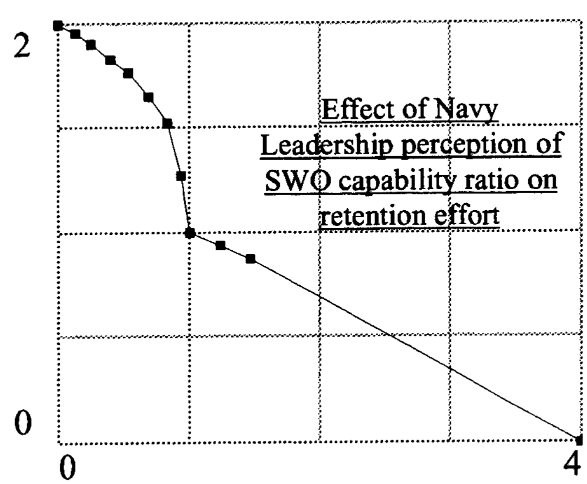

Effect of retention effort ratio on operational performance
2
0
0
2

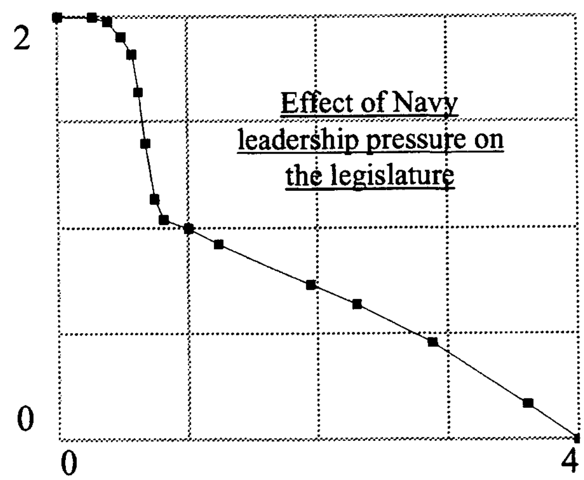

Effect of c of c perception of operational performance on crew pressureon
1.5
1
0
2

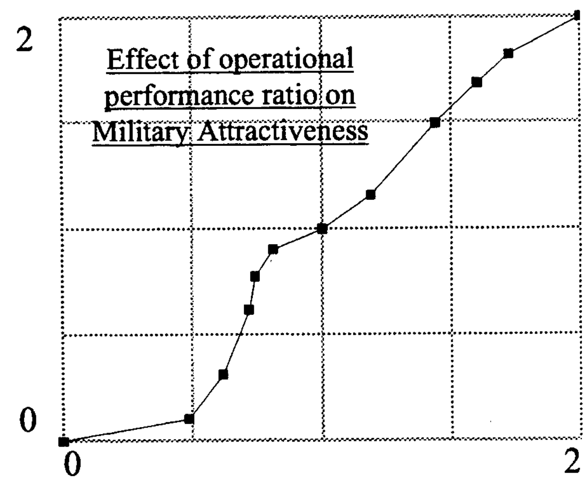

Effect of crew pressure ratio on military attractiveness
4
0
0
4

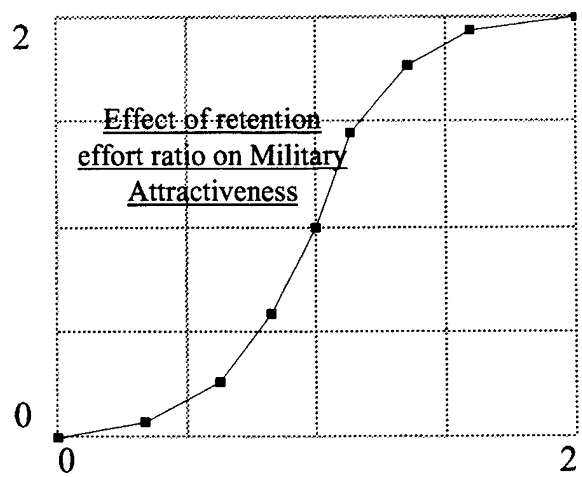

Effect of c of c perception of operational performance ratio on retention effort
2
0
0
2

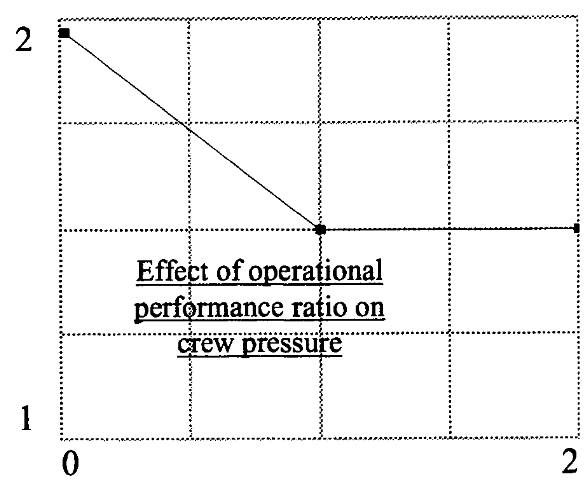

Effect of crew pressure ratio on burnout
2
0
0
6


Effect of Navy Leadership perception of SWO capability ratio on retention effort
2
0
0
4


2
0
0
4
Effect of Navy leadership pressure on the legislature


2
0
0
2
Effect of operational performance ratio on Military Attractiveness


2
0
0
2
Effect of retention effort ratio on Military Attractiveness


2
1
0
2
Effect of operational performance ratio on crew pressure

Appendix D
Initialization Data

SWO Community Management Model Initialization Data

	'01	'00	99	98	97	96	95	94	93	92	91	90
ENS	159	974	754	1	0	1						
LTJG			132	739	628	11	1					
LT					73	605	512	327	216	209	195	36
LCDR									2	1	3	139
CDR												
CAPT												
OPA		0	974	886	740	701	617	513	327	218	210	198
SWO		662.5	662.5	502.5	502.5	223.7	223.7	223.7	223.7	223.7	223.7	213.8
Afloat									245	245	245	

SWO Community Management Model Initialization Data

	89	88	87	86	85	84	83	82	81	80	79	78
ENS												
LTJG												
LT	5	2										
LCDR	175	160	213	157	108	39	29	42	4			
CDR					104	130	151	187	148	138	64	33
CAPT										1	62	87
OPA	175	180	162	213	157	212	169	180	229	152	139	126
SWO	213.8	213.8	213.8	213.8	117.7	117.7	117.7	117.7	117.7	117.7	40.4	40.4
Afloat		105	105					60	60			

SWO Community Management Model Initialization Data

	77	76	75	74	73	72	71	70	69
ENS									
LTJG									
LT									
LCDR									
CDR	29	10	7					1	
CAPT	81	60	71	48	44	40	19	2	0
OPA	120	110	70	78	48	44	40		
SWO	40.4	40.4	40.4	40.4	40.4	40.4	40.4	40	40
Afloat	30	30							

SWO Community Management Model Initialization Data

Years of Service		0	1	2	3	4	5	6	7	8	9	10
	01	00	99	98	97	96	95	94	93	92	91	90
Forcing out		0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.05
attrition		0.08	0.07	0.06	0.05	0.04	0.03	0.02	0.01	0.01	0.01	0.01
retirement		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
resignation		0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.10	0.10
lateral transfers in		0.00	0.05	0.04	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01
lateral transfers out		0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03

SWO Community Management Model Initialization Data

Years of Se	11	12	13	14	15	16	17	18	19	20	21	22
	89	88	87	86	85	84	83	82	81	80	79	78
Forcing out	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.02	0.02
attrition	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
retirement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.10
resignation	0.10	0.10	0.05	0.05	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00
lateral trans	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
lateral trans	0.03	0.03	0.03	0.03	0.03	0.03	0.01	0.01	0.01	0.01	0.02	0.02

SWO Community Management Model Initialization Data

Years of Se	23	24	25	26	27	28	29	30	31
	77	76	75	74	73	72	71	70	69
Forcing out	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
attrition	0.01	0.01	0.01	0.01	0.01	0.01	0.01		
retirement	0.10	0.10	0.10	0.10	0.10	0.10	0.99		
resignation	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
lateral trans	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
lateral trans	0.02	0.02	0.02	0.03	0.03	0.03	0.04		

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